



## VERIFICATION OF TRANSLATION

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1. That I am well acquainted with both English and Japanese languages,  
and
2. That the attached document is a true and correct translation made by  
me to the best of my knowledge and belief of:

The specification accompanying the Application No. 2003-008873 for a  
Patent made in Japan filed on January 16, 2003.

April 25, 2005

3. Kishimoto

Tatsuhito KISHIMOTO

(No witness required)

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[Indication of Fees]

[Prepaid Register Number] 131935

[Amount of Fee] 21000

[List of Attached Documents]

[Material Name] Specification 1

[Material Name] Abstract 1

[General Power of Attorney Number] 0105701

[Need of Proof] Need

[Document Title] SPECIFICATION

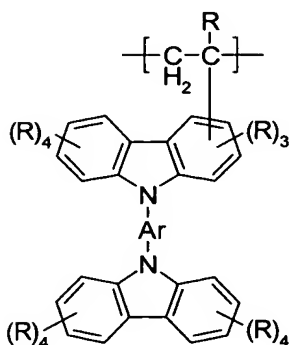
[Title of the Invention] CHARGE TRANSPORTING MATERIAL

[Patent claims]

[Claim 1] A charge transporting material comprising a  
5 compound, a molecular structure of which has at least one  
repeating unit represented by the following formula (1):

[Chemical formula 1]

Formula (1)



10

wherein, "Ar" is a non-substituted or substituted arylene group  
or a non-substituted or substituted heterocyclic group, the  
arylene group having 6 or more to 60 or less carbon atoms and  
forming a conjugated bond system, the heterocyclic group having  
15 4 or more to 60 or less carbon atoms and also forming a conjugated  
bond system, and

wherein, each "R" may be independently selected from the group  
consisting of hydrogen atom, alkyl group having 1 to 20 carbon  
atoms, alkoxy group having 1 to 20 carbon atoms, alkylthio group  
20 having 1 to 20 carbon atoms, alkylsilyl group having 1 to 60  
carbon atoms, alkylamino group having 1 to 40 carbon atoms, aryl

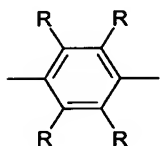
group having 6 to 60 carbon atoms, aryloxyl group having 6 to 60 carbon atoms, arylalkyl group having 7 to 60 carbon atoms, arylalkoxyl group having 7 to 60 carbon atoms, arylalkenyl group having 8 to 60 carbon atoms, arylamino group having 6 to 60 carbon atoms, heterocyclic group having 4 to 60 carbon atoms, cyano group, nitro group, and halogen atoms.

[Claim 2] The charge transporting material according to claim 1, wherein the total number of the repeating units represented by the formula (1) contained in the compound is 5 to 100,000.

10 [Claim 3] The charge transporting material according to claim 1 or 2, wherein the "Ar" in the formula (1) is selected from the group consisting of the structures represented by the following formulas (a) to (j):

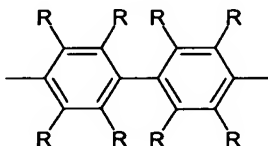
[Chemical formula 2]

15 Formula (a)

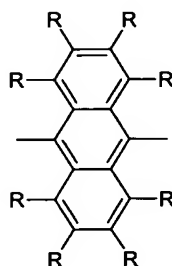
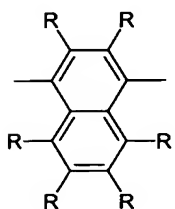


Formula (c)

Formula (b)

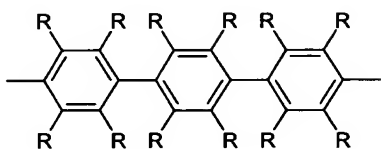


Formula (d)

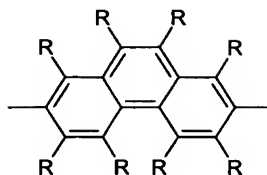


[Chemical formula 3]

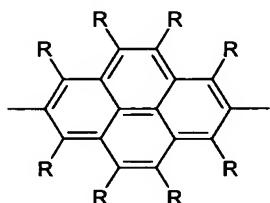
Formula (e)



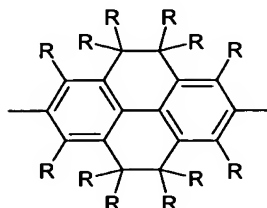
Formula (f)



Formula (g)

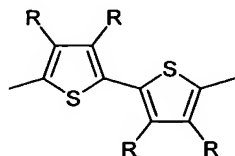


Formula (h)

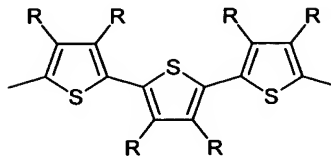


5

Formula (i)



Formula (j)



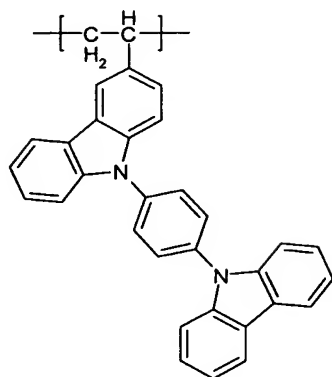
wherein, each "R" is the same as set forth in claim 1.

[Claim 4] The charge transporting material according to any  
10 of claims 1 to 3, wherein the repeating unit represented by the  
formula (1) is at least one selected from the group consisting  
of the structures represented by the following formulas (2) to  
(9):

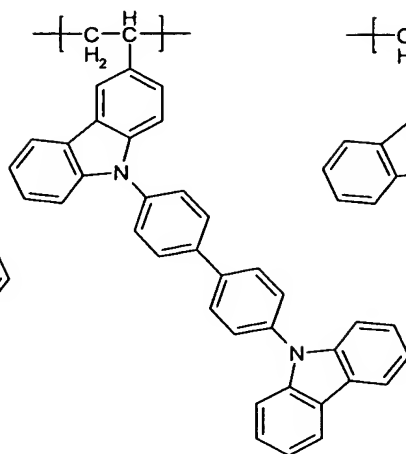
[Chemical formula 4]

15

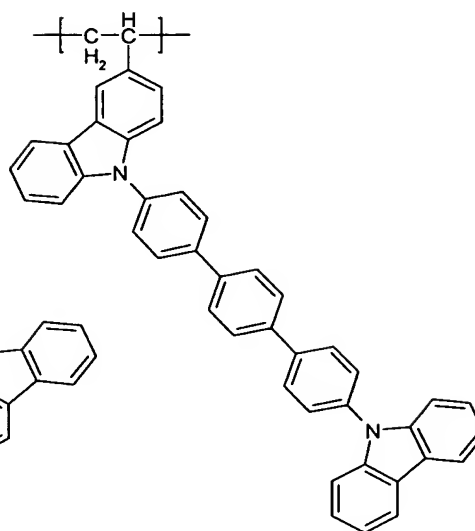
Formula (2)



Formula (3)

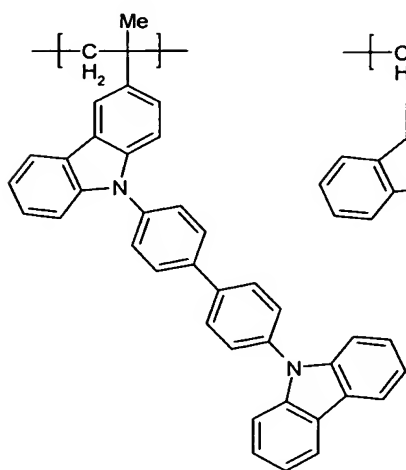


Formula (4)

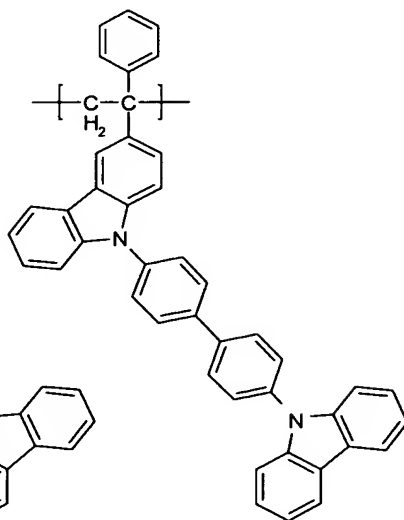


[Chemical formula 5]

5 Formula (5)



Formula (6)

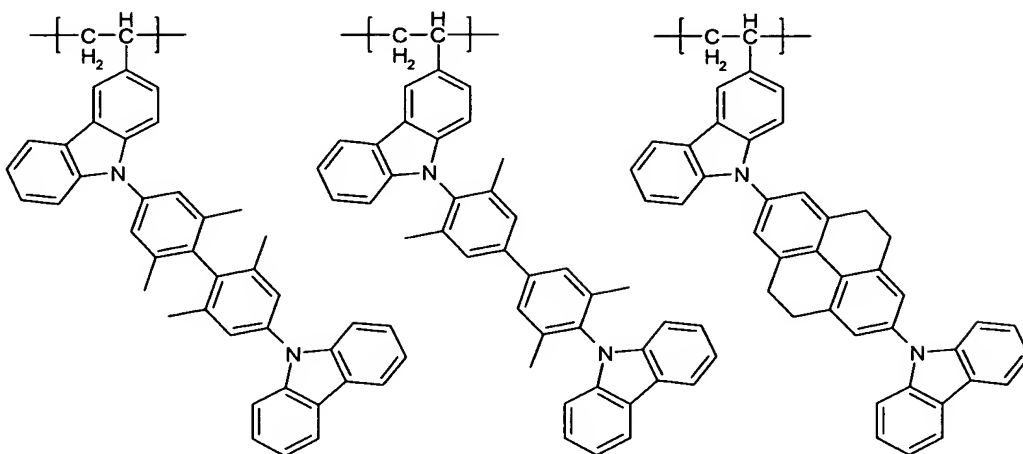


[Chemical formula 6]

Formula (7)

Formula (8)

Formula (9)



5

[Detailed description of the Invention]

[0001]

[Field of the Invention]

10        The present invention relates to a novel polymer material having charge transporting ability, which is applicable to various organic electroelements and devices utilizing the charge transporting function, such as photosensitive device for electrophotography, organic electroluminescent element, 15 photorefractive element, electrochromic element, photosensor, solar battery or the like.

[0002]

[Prior Art]

20        Charge transporting materials are materials having charge transporting ability. When charge is injected in the charge



transporting material, the injected charge causes charge-concentration gradient or electromagnetic gradient within the material to lead diffusion or movement of charge, thereby exhibiting charge transporting activity. The term of  
5 "charge transporting material(s)" includes both meanings of an electron transporting material having ability of transporting electrons as charge and a hole transporting material having ability of transporting holes as charge. The charge transporting materials has been extensively investigated  
10 because it is important to produce organic electro elements and devices such as photosensitive device for electrophotography, organic electroluminescent element, photorefractive element, electrochromic element, photosensor, solar battery or the like.  
[0003]

15 For basic properties of the charge transporting materials, it is required: to be receptive to either one or both of electron and hole when it is in a neutral condition; to be high in the charge transporting ability; to be easily formed into a film-like form; and to be stable when it is formed into an amorphous film.  
20 [0004]

Since the charge transporting materials are often used as a uniform film, it is important to be easily formed into a film-like form. In a case where the charge transporting material is low molecular compound and formed into a film with 1  $\mu\text{m}$  or  
25 less of thickness, vacuum deposition process is generally used as film-forming method. The vacuum deposition process however needs a depositing apparatus which is rather large-scale or

strict than coating process to lead high cost, and use of the depositing apparatus also causes difficulty of producing a large substrate. In addition, when the low molecular compound is solely used to form a film, the film thus formed is inferior  
5 in mechanical strength or thermal stability. For these reasons, a coating technique is adapted in some cases, in which a film of the charge transporting material is formed by dispersing the low molecular compound in high molecular polymer as a binder, and coating with it.

10 [0005]

On the other hand, most of the charge transporting materials are hole transporting materials, for which tertiary amine derivatives such as triarylamine or the like are extensively used. Electron transporting materials of  
15 applicable level include only a few sorts in comparison with the hole transporting materials because the electron transporting materials are not so high in solubility to an organic solvent and therefore not suitable to coating process for formation of film and also not so high in mobility of electron.

20 [0006]

Among the charge transporting materials, there are those having bipolar property provided with both of hole and electron transporting functions. One of examples is CBP, namely 4,4'-Bis(Carbazol-9-yl)-biphenyl (Patent document 1). In  
25 addition to the bipolar property, the CBP further has high transparency, and high matching to a light emitting dopant when the charge transporting material is used for the organic

electroluminescent element. Therefore, the CBP is preferably used for an organic electroluminescent element using a phosphorescence dopant (Non-patent document 1).

[0007]

5           However, the vacuum deposition process is still utilized as a major method to form the film or layer of the charge transporting materials such as the CBP. Moreover, since molecules of the CBP tend to form a plane structure, an amorphous film of the CBP is easily crystallized by time passing or heat.  
10           Therefore, in a case of using the CBP for an electronic device which is attended with heating generation of the Joule heat, such as the organic electroluminescent element, there is a defect that large amount (about 5 to 10 percent) of doping is required or that mixing of the binder is required for prevention of  
15           crystallization. For these reasons, it is difficult to form the film or layer by solely coating with the CBP.

[0008]

[Patent document 1]

Japanese Patent Application Laid-open No. Hei. 10-168443

20           [Non-patent document 1]

M. A. Baldo et al., "Nature", (2000), vol.403, p. 750

[0009]

[Problem to be solved by the Invention]

          In view of these circumstances, an object of the present  
25           invention is to provide a novel charge transporting material, which is excellent in charge transporting ability, hard to crystallize, capable of forming a film or layer by coating process,

and highly adaptable to electronic devices.

[0010]

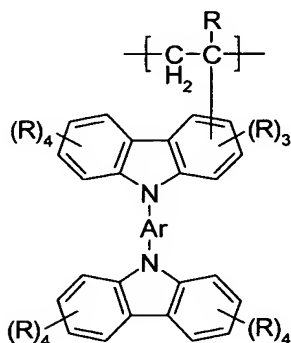
[Means for solving the Problem]

A charge transporting material according to the present  
5 invention comprises a compound, a molecular structure of which  
has at least one repeating unit represented by the following  
formula (1):

[0011]

[Chemical formula 7]

10 Formula (1)



[0012]

wherein, "Ar" is a non-substituted or substituted arylene group  
or a non-substituted or substituted heterocyclic group, the  
15 arylene group having 6 or more to 60 or less carbon atoms and  
forming a conjugated bond system, the heterocyclic compound  
having 4 or more to 60 or less carbon atoms and also forming  
a conjugated bond system, and

wherein, each "R" may be independently selected from the group  
20 consisting of hydrogen atom, alkyl group having 1 to 20 carbon  
atoms, alkoxy group having 1 to 20 carbon atoms, alkylthio group

having 1 to 20 carbon atoms, alkylsilyl group having 1 to 60 carbon atoms, alkylamino group having 1 to 40 carbon atoms, aryl group having 6 to 60 carbon atoms, aryloxy group having 6 to 60 carbon atoms, arylalkyl group having 7 to 60 carbon atoms, arylalkoxy group having 7 to 60 carbon atoms, arylalkenyl group having 8 to 60 carbon atoms, arylamino group having 6 to 60 carbon atoms, heterocyclic group having 4 to 60 carbon atoms, cyano group, nitro group, and halogen atoms.

10 [0013]

It is preferable that total number of the repeating units represented by the formula (1) contained in the compound is 5 to 100,000 in the view point of securing charge transporting ability and film-forming ability.

15 [0014]

[Preferred Embodiment of Invention]

The present invention will be described in detail hereafter.

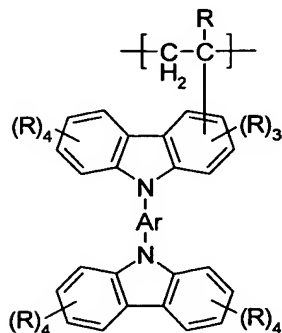
[0015]

First, the following formula (1) will be explained.

20 [0016]

[Chemical formula 8]

Formula (1)



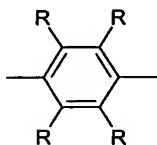
[0017]

The "Ar" in the formula (1) is selected from the group consisting of arylene group and heterocyclic group. The arylene group to be selected has 6 to 60 carbon atoms and it forms a conjugated bond system. The heterocyclic group has 4 or more to 60 or less carbon atoms, and it also forms a conjugated bond system. Concrete examples of the "Ar" include aromatic groups represented by the following formulas (a) to (j) and groups derived from such aromatic groups.

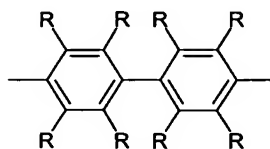
10 [0018]

[Chemical formula 9]

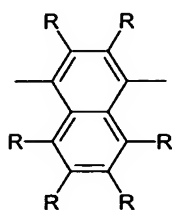
Formula (a)



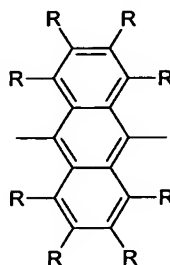
Formula (b)



Formula (c)



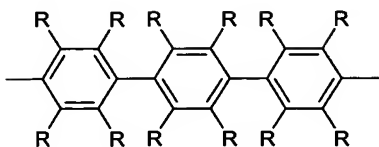
Formula (d)



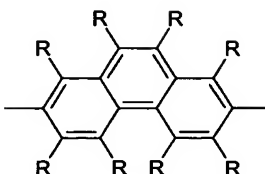
15 [0019]

[Chemical formula 10]

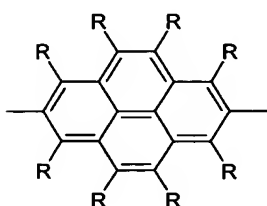
Formula (e)



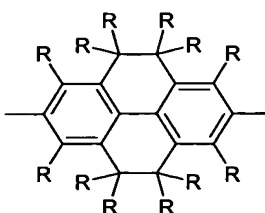
Formula (f)



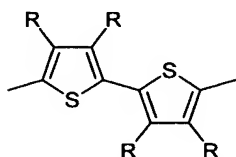
Formula (g)



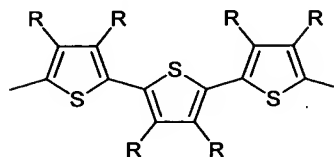
Formula (h)



Formula (i)



Formula (j)



5 [0020]

Preferable ones of these are the groups of 1,4-phenylene, 4,4'-biphenylene and 4,4''-terphenylene, and groups derived from these preferable groups.

[0021]

10 The "R" appearing in the exemplified formulas of "Ar" and the formula (1) is selected from the group consisting of hydrogen atom, alkyl group having 1 to 20 carbon atoms, alkoxy group having 1 to 20 carbon atoms, alkylthio group having 1 to 20 carbon atoms, alkylsilyl group having 1 to 60 carbon atoms, alkylamino group having 1 to 40 carbon atoms, aryl group having 6 to 60 carbon atoms, aryloxy group having 6 to 60 carbon atoms,

15

arylalkyl group having 7 to 60 carbon atoms, arylalkoxyl group having 7 to 60 carbon atoms, arylalkenyl group having 8 to 60 carbon atoms, arylamino group having 6 to 60 carbon atoms, heterocyclic group having 4 to 60 carbon atoms, cyano group, nitro group, and halogen atoms. The respective "R"s present in the same repeating unit may be different from or same as each other.

[0022]

As the alkyl group having 1 to 20 carbon atoms, there may be exemplified methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, sec-butyl, t-butyl, n-hexyl, n-octyl, nonyl, decyl, and lauryl, and preferable examples include pentyl group, hexyl group, octyl group and decyl group.

[0023]

As the alkoxyl group having 1 to 20 carbon atoms, there may be exemplified methoxy, ethoxy, propyloxy, butoxy, pentyloxy, hexyloxy, heptyloxy, octyloxy, nonyloxy, decyloxy and lauryloxy, and preferable examples include pentyloxy group, hexyloxy group, octyloxy group and decyloxy group.

[0024]

As the alkylthio group having 1 to 20 carbon atoms, there may be exemplified methylthio, ethylthio, propylthio, butylthio, pentylthio, hexylthio, heptylthio, octylthio group, nonylthio, decylthio and laurylthio, and preferable examples include pentylthio group, hexylthio group, octylthio group and decylthio group.

[0025]



As the alkylsilyl group having 1 to 60 carbon atoms, there may be exemplified methylsilyl, ethylsilyl, propylsilyl, butylsilyl, pentylsilyl, hexylsilyl, heptylsilyl, octylsilyl, nonylsilyl, decylsilyl, laurylsilyl, trimethylsilyl, ethyldimethylsilyl, propyldimethylsilyl, butyldimethylsilyl, pentyldimethylsilyl, hexyldimethylsilyl, heptyldimethylsilyl, octyldimethylsilyl, nonyldimethylsilyl, decyldimethylsilyl and lauryldimethylsilyl, and preferable examples include pentylsilyl group, hexylsilyl group, octylsilyl group, decylsilyl group, pentyldimethylsilyl group, hexyldimethylsilyl group, octyldimethylsilyl group and decyldimethylsilyl group.

[0026]

As the alkylamino group having 1 to 40 carbon atoms, there may be exemplified methylamino, ethylamino, propylamino, butylamino, pentylamino, hexylamino, heptylamino, octylamino, nonylamino, decylamino, laurylamino, dimethylamino and diethylamino, and preferable examples include pentylamino group, hexylamino group, octylamino group and decylamino group.

[0027]

As the aryl group having 6 to 60 carbon atoms, there may be exemplified phenyl, C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl group (Hereinafter, the "C<sub>1</sub>-C<sub>12</sub>" means number of carbon atoms being in a range of 1 to 12.), C<sub>1</sub>-C<sub>12</sub> alkylphenyl, 1-naphtyl and 2-naphtyl, and preferable examples include C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl group and C<sub>1</sub>-C<sub>12</sub> alkylphenyl group.

[0028]

As the aryloxy group having 6 to 60 carbon atoms, there may be exemplified phenoxy, C<sub>1</sub>-C<sub>12</sub> alkoxyphenoxy, C<sub>1</sub>-C<sub>12</sub> alkylphenoxy, 1-naphtyloxy and 2-naphtyloxy, and preferable examples include C<sub>1</sub>-C<sub>12</sub> alkoxyphenoxy group and C<sub>1</sub>-C<sub>12</sub> alkylphenoxy group.

[0029]

As the arylalkyl group having 7 to 60 carbon atoms, there may be exemplified phenyl-C<sub>1</sub>-C<sub>12</sub> alkyl, C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl-C<sub>1</sub>-C<sub>12</sub> alkyl, C<sub>1</sub>-C<sub>12</sub> alkylphenyl-C<sub>1</sub>-C<sub>12</sub> alkyl, 1-naphtyl-C<sub>1</sub>-C<sub>12</sub> alkyl, 2-naphtyl-C<sub>1</sub>-C<sub>12</sub> alkyl, and preferable examples include C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl-C<sub>1</sub>-C<sub>12</sub> alkyl group and C<sub>1</sub>-C<sub>12</sub> alkylphenyl-C<sub>1</sub>-C<sub>12</sub> alkyl group.

[0030]

As the arylalkoxy group having 7 to 60 carbon atoms, there may be exemplified phenyl C<sub>1</sub>-C<sub>12</sub> alkoxy, C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl-C<sub>1</sub>-C<sub>12</sub> alkoxy, C<sub>1</sub>-C<sub>12</sub> alkylphenyl-C<sub>1</sub>-C<sub>12</sub> alkoxy, 1-naphtyl-C<sub>1</sub>-C<sub>12</sub> alkoxy, 2-naphtyl-C<sub>1</sub>-C<sub>12</sub> alkoxy, and preferable examples include C<sub>1</sub>-C<sub>12</sub> alkylphenyl-C<sub>1</sub>-C<sub>12</sub> alkoxy group.

[0031]

As the arylalkenyl group having 8 to 60 carbon atoms, there may be exemplified phenyl C<sub>1</sub>-C<sub>12</sub> alkenyl, C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl-C<sub>1</sub>-C<sub>12</sub> alkenyl, C<sub>1</sub>-C<sub>12</sub> alkylphenyl-C<sub>1</sub>-C<sub>12</sub> alkenyl, 1-naphtyl-C<sub>1</sub>-C<sub>12</sub> alkenyl and 2-naphtyl-C<sub>1</sub>-C<sub>12</sub> alkenyl, and preferable examples include C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl-C<sub>1</sub>-C<sub>12</sub> alkenyl group and C<sub>1</sub>-C<sub>12</sub> alkylphenyl-C<sub>1</sub>-C<sub>12</sub> alkenyl group.

[0032]

As the arylamino group having 6 to 60 carbon atoms, there

may be exemplified phenylamino, diphenylamino, C<sub>1</sub>-C<sub>12</sub> alkoxyphenylamino, di(C<sub>1</sub>-C<sub>12</sub> alkoxyphenyl)amino, di(C<sub>1</sub>-C<sub>12</sub> alkylphenyl)amino and 1-naphtylamino, 2-naphtylamino, and preferable examples include C<sub>1</sub>-C<sub>12</sub> alkylphenylamino group,  
5 di(C<sub>1</sub>-C<sub>12</sub> alkylphenyl)amino group.

[0033]

As the heterocyclic group having 4 to 60 carbon atoms, there may be exemplified thienyl, C<sub>1</sub>-C<sub>12</sub> alkylthienyl, pyrrolyl, furyl, pyridyl and C<sub>1</sub>-C<sub>12</sub> alkylpyridyl group, and preferable  
10 examples include C<sub>1</sub>-C<sub>12</sub> alkylthienyl group and C<sub>1</sub>-C<sub>12</sub> alkylpyridyl group.

[0034]

As the halogen atom, there may be exemplified fluorine, chlorine, bromine, iodine or the like.

15 [0035]

Among the examples of "R", substituents containing alkyl group may be straight, branched or cyclic chain, or may be combination thereof. Examples but are not straight chain include isoamyl group, 2-ethylhexyl group, 3,7-dimethyloctyl  
20 group, cyclohexyl group and 4-C<sub>1</sub>-C<sub>12</sub> alkylcyclohexyl group.

[0036]

At least one of the "R"s appearing in the exemplified formulas of the Ar and at least one of other "R"s appearing in the formula (1) may be bonded to each other to form a five-member  
25 or six-member ring which may be saturated or not. But the bonded portion may not form a cyclic structure.

[0037]

Examples of the repeating unit represented by the formula (1) include the units represented by the following formulas (2) to (9).

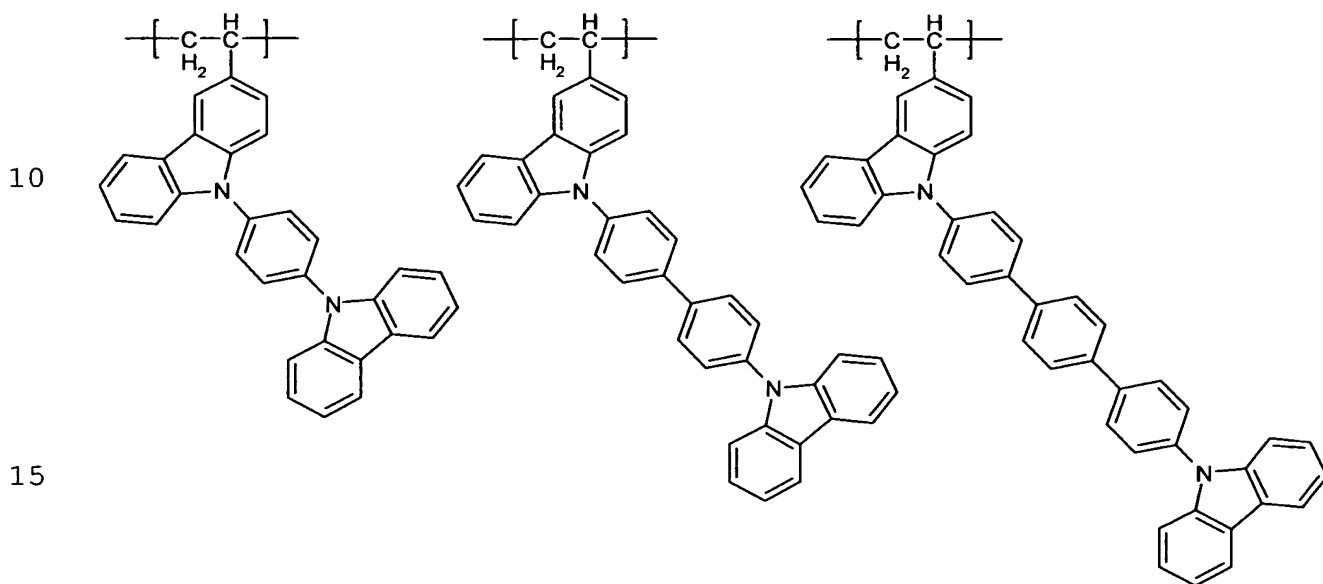
[0038]

5 [Chemical formula 11]

Formula (2)

Formula (3)

Formula (4)

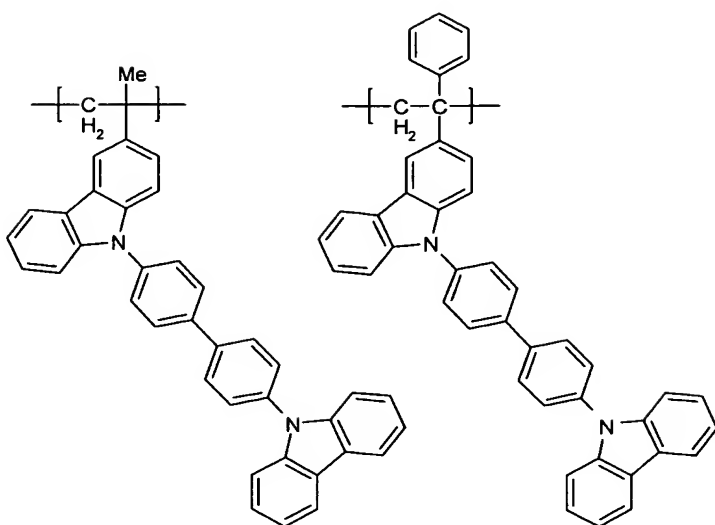


[0039]

[Chemical formula 12]

20 Formula (5)

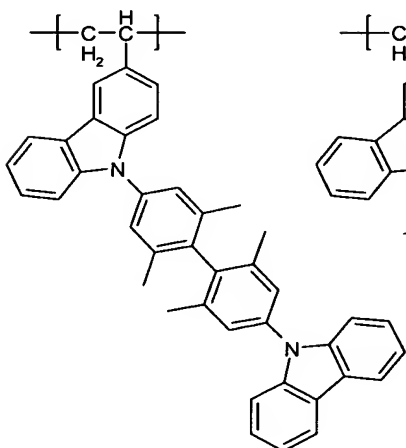
Formula (6)



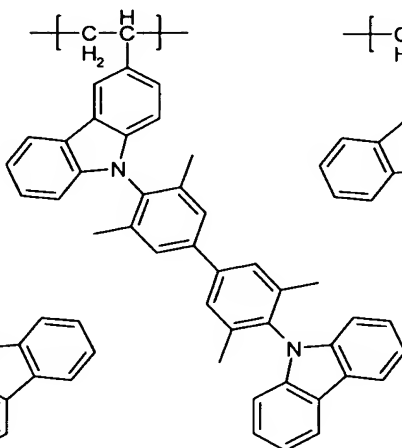
[0040]

[Chemical formula 13]

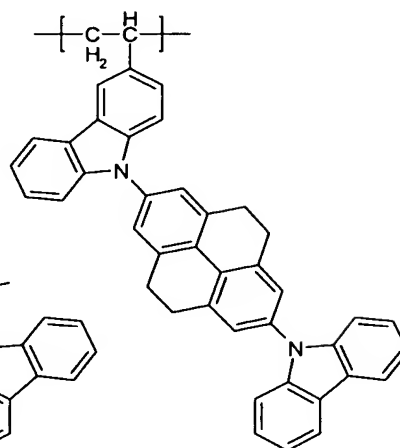
Formula (7)



Formula (8)



Formula (9)



5

[0041]

On the use of polyvinylcarbazole which is common as the hole transporting material, there is known a problem that the adjacent carbazole groups are liable to stack up and form an excimer. Formation of the excimers causes some problems that the excimers serve as a trap for charge to obstruct the transport of charge, or that the excimers serve as a quenching center when

using it in combination with a light emitting material to obstruct the light emission. In the preferable case of the present invention, "R" as the substituent selected from the above mentioned groups is introduced into a molecular structure of the charge transporting material to prevent the plural repeating units represented by the formula (1) from stacking up, thereby avoiding formation of the excimers.

[0042]

Total number of the repeating units of the formula (1) is preferably 5 to 100,000, more preferably 10 to 10,000, and still more preferably 20 to 5,000.

[0043]

The compound of the present invention has at least one repeating unit selected from the formula (1). It may be a homopolymer consisting of the repeating units of the formula (1), or a copolymer using two or more kinds of the repeating units, all of which are selected from the formula (1), or further may be a copolymer using at least one kind of the repeating units of the formula (1) in combination with monomers other than the formula (1). In a case of being the copolymer, it may be a random, block or graft copolymer, or may be a polymer having an intermediate structure such as a random copolymer imparted with a block structure.

[0044]

As a monomer which can be used to copolymerization with the repeating unit of the formula (1), there is not particularly limited. However, it is preferable if the repeating unit has

a structure capable of preventing its solubility from lowering to organic solvents, or capable of preventing its charge transporting ability from lowering. For example, vinylcarbazole or vinyl(triphenylamine) may be preferable.

5 [0045]

Amount ratio of the repeating unit of the formula (1) varies according to the structure of the used repeating unit, and a preferable range is generally 50 mol% or more and 100 mol% or less on the basis of total amount of monomer component as 100 mol%, and more preferable is 70 mol% or more and 100 mol% or less.

[0046]

In the present invention, polymerization degree of the compound varies according to conditions such as a structure or amount ratio of repeating unit. However, number average molecular weight indicated with polystyrene standard is preferably in a range of  $10^3$  to  $10^8$ , and if solubility and film-forming ability are considered, a range from  $10^4$  to  $10^6$  is more preferable. The molecular weight referred here is number average molecular weight measured by means of the gel permeation chromatography (GPC) using chloroform as the solvent and polystyrene as the standard.

20 [0047]

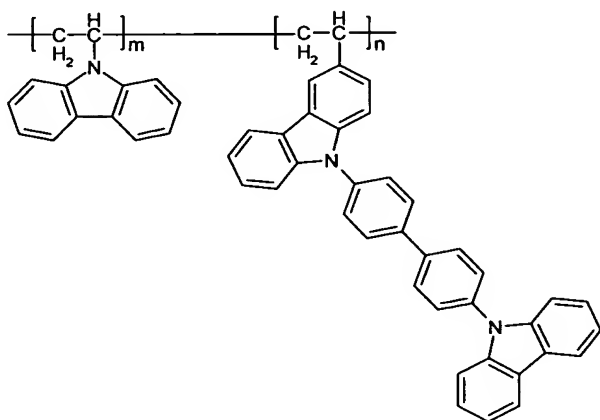
The compound of the present invention may contain a structure or skeleton having the hole transporting function or the electron transporting function, which is located at a site of a repeating unit derived from other monomer, which is to be

copolymerized. For example, there may be a copolymer containing polyvinylcarbazole skeleton having the hole transporting function, one concrete example of which is represented by the following formula (10):

5 [0048]

[Chemical formula 14]

Formula (10)



[0049]

wherein, "m" and "n" are integer of 1 or more.

10

Furthermore, the compound of the present invention may contain a structure or skeleton having the light emitting function or other functions, which is located at a site of other monomer, which is to be copolymerized. Specifically, there may be exemplified a copolymer represented by the following formula (11):

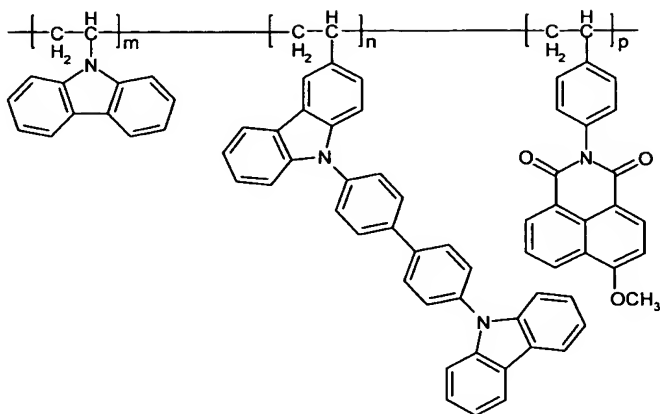
15

[0050]

[Chemical formula 15]



Formula (11)



[0051]

5 wherein, "m", "n" and "p" are integer of 1 or more.

A polymerization method for producing the compound of the present invention is not particularly limited. Adaptable methods include radical polymerization, ion polymerization or  
 10 the like, and the radical polymerization process is preferable. As initiators for radical polymerization, there may be used azo compounds, peroxides or the like, and preferable initiators are azobisisobutyronitrile, derivatives of azobisisobutylic acid diester, and benzoyl peroxide.

15 [0052]

A solvent for polymerization is also not particularly limited, and examples of the solvent include aromatic hydrocarbons (for example, benzene and toluene), halogenated hydrocarbons (for example, dichloroethane and chloroform),  
 20 ethers (for example, tetrahydrofuran and dioxane), amides (for example, dimethylformamide and dimethylacetoamide), esters

(for example, ethyl acetate), alcohols (for example, methanol), ketones (for example, acetone and cyclohexanone) or the like. Choice of the solvent enables either processes of the solution polymerization in which homogeneous polymerization is carried out and the precipitation polymerization in which a produced polymer is precipitated.

[0053]

In a case of using these polymers as the charge transporting material for organic electro elements and devices, its purity affects the charge transporting property and the stability of amorphous state in the film or layer. Therefore, after the synthesizing of the polymer, it is desirably subjected to any purification treatment such as the purification through reprecipitation, the fractionation through chromatography or the like.

[0054]

The charge transporting material of the present invention is dissolved in a solvent, and a film or layer can be formed through a coating process using the prepared coating liquid. Examples of good solvent for the charge transporting material include chloroform, methylene chloride, dichloroethane, tetrahydrofuran, toluene and xylene. In general, the charge transporting material can be dissolved in any one of these solvents at 0.1% by weight or more, though dissolving amount varies according to a structure or molecular weight of the charge transporting material. On the production of the electronic devices, a coating process is carried out with the use of a solution

prepared from the charge transporting material which is soluble to the organic solvent, and thereafter the solvent is removed by drying, so that a layer or a film can be simply formed. Therefore, it is quite advantageous to production process.

5 [0055]

Any coating method using a material in melted state, solution, dispersed liquid or mixed liquid of the charge transporting material is adaptable, and preferable methods are spin coating, cast coating, dip coating, die coating, bead  
10 coating, bar coating, roll coating, spray coating, gravure coating, flexo printing, screen printing, offset printing or the like.

[0056]

In a case of forming the film or layer through coating  
15 process, the film or layer is heated and dried at preferably 30 °C to 300 °C, and more preferably 60 °C to 200 °C in order to remove the solvent, and it is still more preferable to carry out this process under the reduced pressure or under the inert atmosphere.

20 [0057]

[Examples]

Though the present invention will be hereinafter explained by way of examples, the scope of the present invention is not restricted by these examples.

25 [0058]

<Synthesis of Charge transporting material>

0.80 g of phosphorus oxychloride was added into 50 mL of

N,N-dimethylformamide and stirred at room temperature to be dissolved. Herein, a solution prepared by dissolving 2.42 g of CBP in 15 mL of dry chloroform was added and stirred at room temperature to obtain formyl-product of CBP  
5 (4-(Carbazol-9-yl)-4'-(3-formylcarbazol-9-yl)-biphenyl).

On the other hand, 1.83 g of triphenylphosphine was added into 50 mL of benzene to be dissolved. Then 0.67 g of bromomethane was added therein and stirred at room temperature to produce phosphonium salt. The phosphonium salt thus obtained was  
10 dissolved in 50 mL of dry diethyl ether under dry nitrogen flow, and 4.4 mL of butyl lithium solution in hexane (1.6 M) was further added and stirred at room temperature to produce phosphoylide. Then 2.18 g of the formyl-product of CBP which is dissolved in 20 mL of dry diethyl ether was further added therein to allow  
15 Wittig reaction, thereby producing vinyl-product of CBP (4-(Carbazol-9-yl)-4'-(3-vinylcarbazol-9-yl)-biphenyl).

[0059]

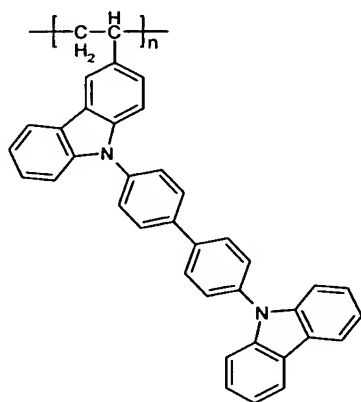
1.8 g of the vinyl-product of CBP was dissolved in 50 mL of dry tetrahydrofuran under dry nitrogen flow, and 3 mg of  
20 azobisisobutyronitrile was further added and stirred at room temperature for 12 hours to allow polymerization. Then the reacted solution was poured into 100 mL of methanol, and solid contents therein were washed by diluted hydrochloric acid. Thereafter, soluble components were removed by means of a Soxhlet  
25 reflux condenser using acetone as the solvent to separate an insoluble fraction. This insoluble fraction was dissolved in chloroform and subjected to reprecipitation using methanol, thus

obtaining a target polymer (formula (12)). Hereafter, the obtained polymer is referred as the charge transporting material 1.

[0060]

5 [Chemical formula 16]

Formula (12)



[0061]

wherein, "n" is integer of 1 or more.

10           The charge transporting material 1 was soluble to aromatic solvents such as toluene and xylene, halogenated hydrocarbon solvents such as chloroform and 1,2- dichloroethane, and ether solvents such as tetrahydrofuran. Number average molecular weight of the charge transporting material 1 based on polystyrene  
15 standard was determined by gel permeation chromatography (GPC) using chloroform as solvent, and a determined value was  $1.0 \times 10^4$ . For a structure of the charge transporting material 1, corresponding spectra of <sup>1</sup>H-NMR and IR spectrum were obtained.

[0062]

(Evaluation)

<Evaluation for Film-forming ability>

The charge transporting material 1 can be easily solved  
5 to chloroform. 2% by weight of charge transporting material  
1 solution in chloroform was subjected to spin coating on a quartz  
substrate to form a thin layer of the charge transporting material  
1 with thickness of 200 nm. The charge transporting material  
1 can be formed into the thin layer by spin coating without doping  
10 or mixing of binder.

[0063]

<Measurement of Energy level>

The thin layer of the charge transporting material 1  
obtained in the example was tested to measure work function and  
15 electron affinity. The work function was measured by means of  
an atmosphere-ultraviolet photoelectron spectrometer (AC-1  
available from Riken Keiki Co., Ltd.) and a measured value was  
5.53 eV. On the other hand, the electron affinity was calculated  
from the value of work function which was measured by the method  
20 described above and a value of band gap which was calculated  
from a value at an outermost end on a long wavelength side of  
absorption spectrum measured by means of an ultraviolet-visible  
spectrophotometer (MPC-3100 available from Shimazu  
Corporation), and a calculated value was 2.21 eV. These values  
25 were comparable to a work function of CBP (5.52 eV) and electron  
affinity of CBP (1.89 eV) respectively. As a result, it was  
found that the charge transporting material 1 could be used

similarly to CBP in the point of work function and electron affinity, and furthermore, could be formed into a layer by coating process.

[0064]

5 [Effect of the Invention]

As described above, the charge transporting material of high molecular polymer according to the present invention is quite useful material for materials having charge transporting ability.

10 [0065]

The charge transporting material of the present invention is easy to be synthesized, and it can be formed into a thin film or layer by coating process without doping or mixing of binder. Therefore, it is advantageous in comparison with a case of using the conventional CBP as the charge transporting material in the points that it has good stability and enables production of electro devices with low cost.

[0066]

Moreover, the charge transporting material of the present invention has advantages that charge transporting ability thereof can be controlled in accordance with purposes by changing concentration of the repeating units of the formula (1), or by changing a kind of repeating unit of the formula (1), or by using a combination of two or more kinds of repeating units all of which fall in the formula (1) but are different from each other, and that coating suitability thereof can be improved and shape or configuration and electrical property of the layer can be

optimized by introducing proper monomer to be copolymerized.



[Document Title] ABSTRACT

[Abstract]

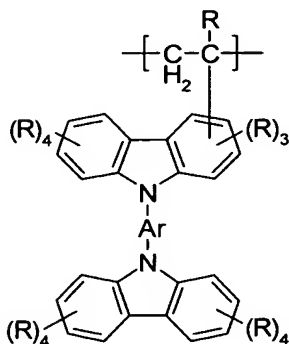
[Object] The present invention provides a novel charge transporting material, which is excellent in charge transporting ability, hard to crystallize, capable of forming a film or layer by coating process, and highly adaptable to electronic devices.

[Means of Solution] A charge transporting material provided by the present invention comprises a compound, a molecular structure of which has at least one repeating unit represented by the

following formula (1):

[Chemical formula 1]

Formula (1)



wherein, "Ar" is a non-substituted or substituted arylene group having 6 or more to 60 or less carbon atoms related to a conjugated bond or a non-substituted or substituted heterocyclic group having 4 or more to 60 or less carbon atoms related to a conjugated bond, and

wherein, each "R" may be independently selected from the group consisting of hydrogen atom, alkyl group having 1 to 20 carbon atoms, alkoxy group having 1 to 20 carbon atoms, alkylthio group

having 1 to 20 carbon atoms, alkylsilyl group having 1 to 60 carbon atoms, alkylamino group having 1 to 40 carbon atoms, aryl group having 6 to 60 carbon atoms, aryloxyl group having 6 to 60 carbon atoms, arylalkyl group having 7 to 60 carbon atoms, 5 arylalkoxyl group having 7 to 60 carbon atoms, arylalkenyl group having 8 to 60 carbon atoms, arylamino group having 6 to 60 carbon atoms, heterocyclic group having 4 to 60 carbon atoms, cyano group, nitro group, and halogen atoms.

[Elected Drawing] None